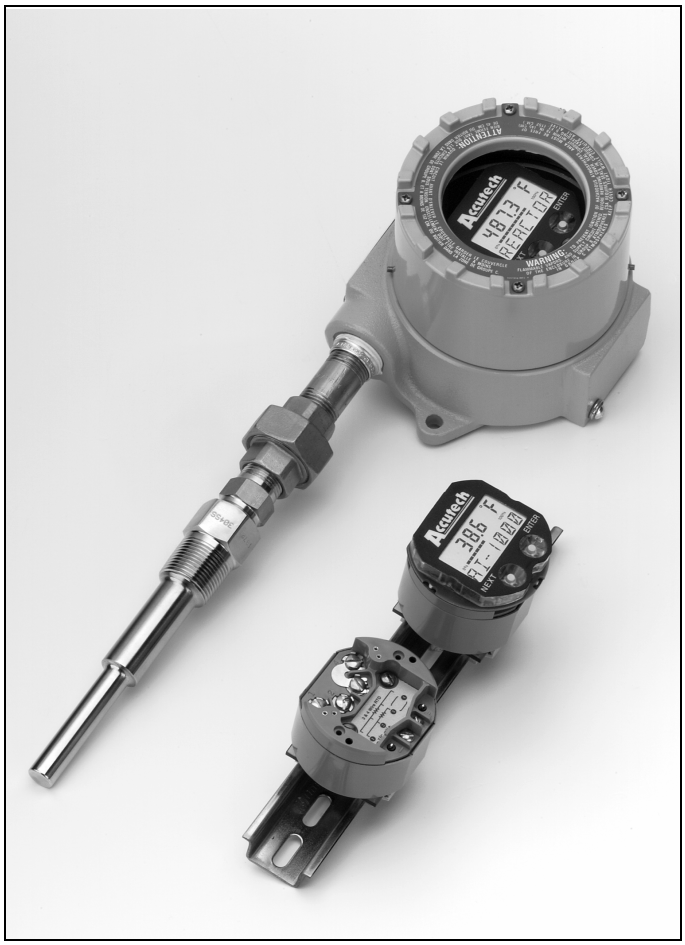
MODEL AI-1000 R2 PROGRAMMABLE TEMPERATURE TRANSMITTER

Operating Information



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1.0 INTRODUCTION

The AI-1000 R2 is a Programmable compatible, isolated, two-wire, transmitter that accommodates any one of eleven types of thermocouples, six types of RTD's, millivolt or ohm inputs. The unit is precision linearized to the measured temperature over the entire usable range of the selected sensor. This transmitter is simple to set up and operates much like high performance analog transmitters.

The AI-1000 R2 also has numerous advanced features that are achieved through the use of digital signal processing and micro-controller technologies. Typical of these features are the precision linearization, the independent zero and full scale settings, digital filtering, etc. Other advanced features, such as the automatic self diagnostics, and the exceptional stability are transparent to the user and are continuously active.

The AI-1000 R2 transmitter can also accept one of two optional plug-in displays. The DK-1 is an inexpensive, single line display that is intended to give a low-cost, local indication of the measured temperature. The DK-2 two line display will give a local indication and functions as a very easy-to-use set-up tool. Both displays facilitate local configuration and ranging of the transmitter.

This manual is divided into several sections. After a brief *INTRODUCTION*, the section on *UNPACKING AND INSTALLATION* contains much useful information for the first time installer. The section called *IN A HURRY?* helps get the system operating provided the sensor and transmitter were purchased at the same time and thus most of the set up was completed at the factory. The next two sections explain the method of *CONFIGURATION* using either display. Finally, there is additional *APPLICATION INFORMATION* and the *TECHNICAL SPECIFICATIONS* included in the sections under those headings.

The AI-1000 R2 temperature transmitter does not have any potentiometers or switches to set and there are no user serviceable components inside the transmitter. Opening the enclosure will void the manufacturer's warranty. All reconfiguration, re-ranging and "calibration" can be done in the field using either one of the displays. Any of the communication methods provides reconfiguration and re-ranging capabilities without other external calibration tools.

2.0 UNPACKING AND INSTALLATION

2.1 Unpacking

Remove the Packing List to check off the actual equipment received. If you have any questions on your shipment, please call Adaptive Wireless solutions at (978) 875 6000 . Upon receipt of shipment, inspect the container for any signs of damage in transit. Especially take note of any evidence of rough handling. Report any apparent damage immediately to the shipping agent.

> ***NOTE:*** *The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing the contents, save the packing material and carton in the event reshipment is necessary.*

2.2 Mechanical Installation

Proper installation of the transmitter will assure highest performance and minimize errors of the measured variable. The transmitter should be mounted in a location that minimizes temperature extremes, vibration and shock. It is important to survey the area to ascertain the best location for installation. Will the location be subjected to flooding? Is the location directly above, below or in proximity to a known high heat source? Does the location make the transmitter unserviceable?

The installation recommendations outlined in this section are provided to act as a guideline only and cannot cover all possible variations. The final installation must be made at the discretion and approval of the user.

2.21 Weather Proof/Explosion Proof Housing

Several optional transmitter housings are available. The XP-FN is an Explosion Proof / Weather Proof housing that accommodates a transmitter when the local display option is not required. The XP-FG, with its glass window, may be used in hazardous and wet locations when the display option is desired. The XP-HEAD is a small electrical head that can be used without local indication in Explosion Proof environments. The WP-HEAD is a small aluminum Weatherproof head designed for head mounting the transmitter without local indication. These housings have appropriate mounting means in the bottom to attach the AI-1000 R2 in any of four orientations 90° apart. Captive 8-32 machine screws are installed on the transmitter to facilitate installation and removal to either a housing bottom plate or to a mounting panel.

Please note that condensation often occurs inside conduit attached to Weather Proof or Explosion Proof housings. Care must be taken so that liquid condensation does not accumulate and fill the transmitter housing with liquid. While the transmitter is sealed, we do not recommend operating it immersed in liquid. Conductive liquids across the top of the transmitter will short the input and loop terminals. This installation problem can appear to a control system as a transmitter failure.

2.22 Mounting

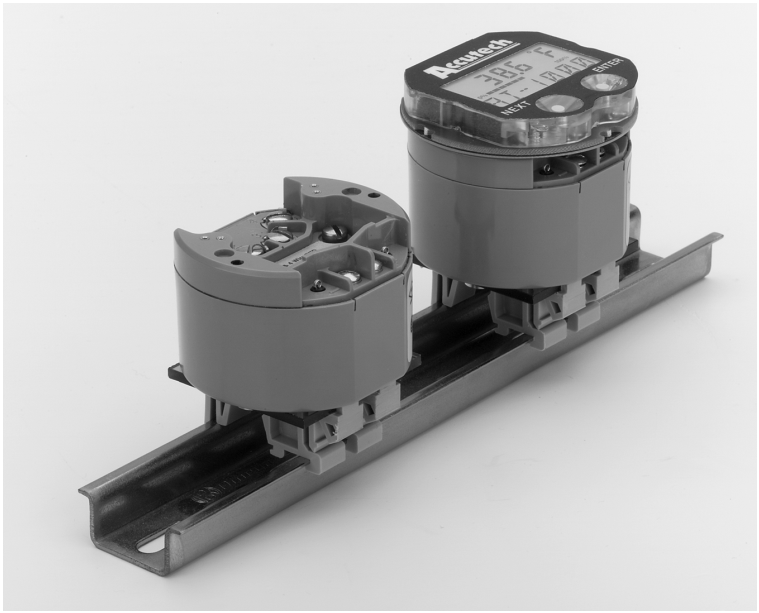
The AI-1000 R2 transmitter may be head mounted, mounted on a 2 inch pipe (vertical or horizontal), on a bulkhead, a panel, a DIN rail or other rigid support members utilizing the various mounting brackets and associated hardware available from Accutech. These types of mounts provide greater flexibility in installation and removal of the transmitter for service. In locations where extreme temperature variations are encountered, it is strongly recommended that enclosures be provided to maintain a somewhat constant temperature at the transmitter. Heaters or steam tracing should be provided if the ambient temperature variations are extreme.

Figure 2-1 The XP-FG Explosion Proof Housing with PY-2 Pipe Mounting bracket

2.221 DIN Rail Mounting

A bracket is available if DIN rail mounting of the AI-1000 R2 is desired. See Figure 2-2.

Figure 2-2 Optional DIN Rail Mounting Bracket



2.222 Head Mounting

All Explosion Proof / Weatherproof housings can be used for head mounting. All heads have two ½" female NPT conduit entries. One of these conduit entries can be used to mount directly onto a ½" male NPT extension of the sensor. Alternatively, a ½" NPT union coupling can be placed between the housing and the temperature sensor. Note that the XP-HEAD and WP-HEAD cannot be used with a pipe mount bracket. For non-display pipe mount bracket installations, use the XP-FN Housing.

Figure 2-3 Optional Weather Proof Housing

2.223 Surface Mounting

The transmitter has two mounting holes through the body of the transmitter. These mounting holes allow the transmitters to be attached to any flat surface by means of two bolts or screws. The transmitter is provided with 8/32 captive screws already installed.

2.224 Pipe Mounting

A stainless steel bracket is available for pipe mounting. Use the PY-2 for mounting the XP-FN or XP-FG housing onto any 2" pipe. Note that the XP-HEAD and WP-HEAD are not suitable for Pipe Mounting. The housing is attached to the bracket as shown in Figure 2-1.

2.3 ELECTRICAL INSTALLATION

The AI-1000 R2 has two groups of terminals. One terminal group is for the sensor input. The second terminal group is for transmitter output. The terminals labeled “+” and “-” are the 4 to 20mA output terminals. These are normally connected to the corresponding polarity terminals of the power supply of the current loop. Refer to Figure 2-4 for the arrangement of the output terminal connections.

Terminals labeled "1,2,3 and 4" are used in various connections to accommodate the different sensor inputs. Refer to Figure 2-5 for the arrangement of the input terminal connections.

NOTE

For Intrinsically Safe Applications, please refer to the Intrinsic Safety Control Drawings included in this manual on page

2.31 Output Terminals

The output terminals, labeled “+” and “-”, are generally connected to a power supply having a nominal 24 Volt DC voltage and capable of supplying 23mA for the AI-1000 R2. The “+” and “-” terminals of the transmitter are connected to the corresponding polarity terminals of the power supply.

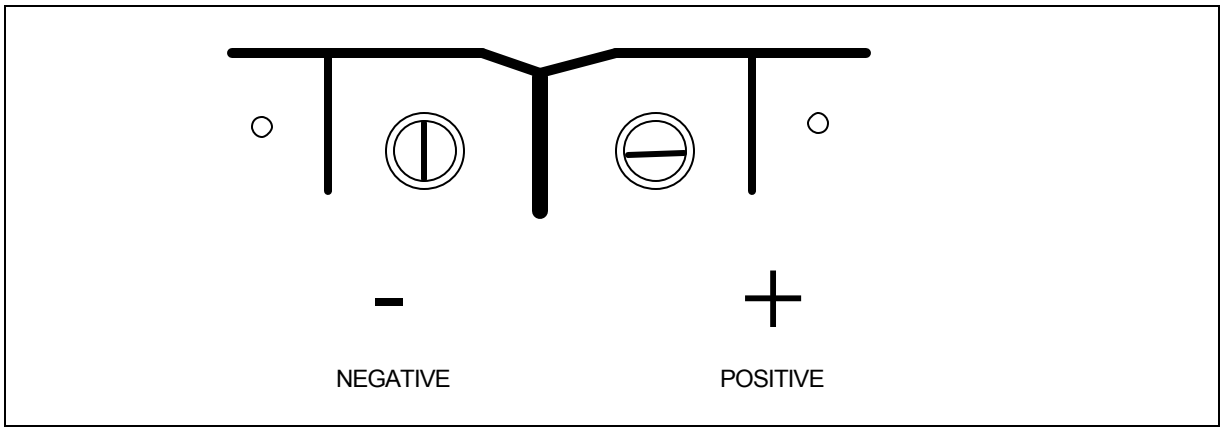


Figure 2-4 Output Terminal Connections

A load resistor, typically 250 ohms, may be connected in series with either terminal of the transmitter. For Digital communications, 250 ohms must be connected in the loop. The maximum series resistance in the circuit (including wiring lead resistance) can be calculated using the formula:

$$Rs = \frac{Vs - 12}{0.023}$$

The following chart gives maximum series resistance:

Max. Series Resistance, Rs	Supply Voltage, Vs
1300 ohms	42.0 Volts
520 ohms	24.0 Volts
417 ohms	21.6 Volts
250 ohms	18.0 Volts
0 ohms	12.0 Volts

2.32 Input Terminals

See Figure 2-5 for sensor input connections. Be certain to include the proper jumpers for thermocouple sensors and for two or three wire RTD inputs. Any sensor other than the four-wire RTD requires at least one external jumper. A jumper is supplied with the unit and is attached to terminals 3 and 4.

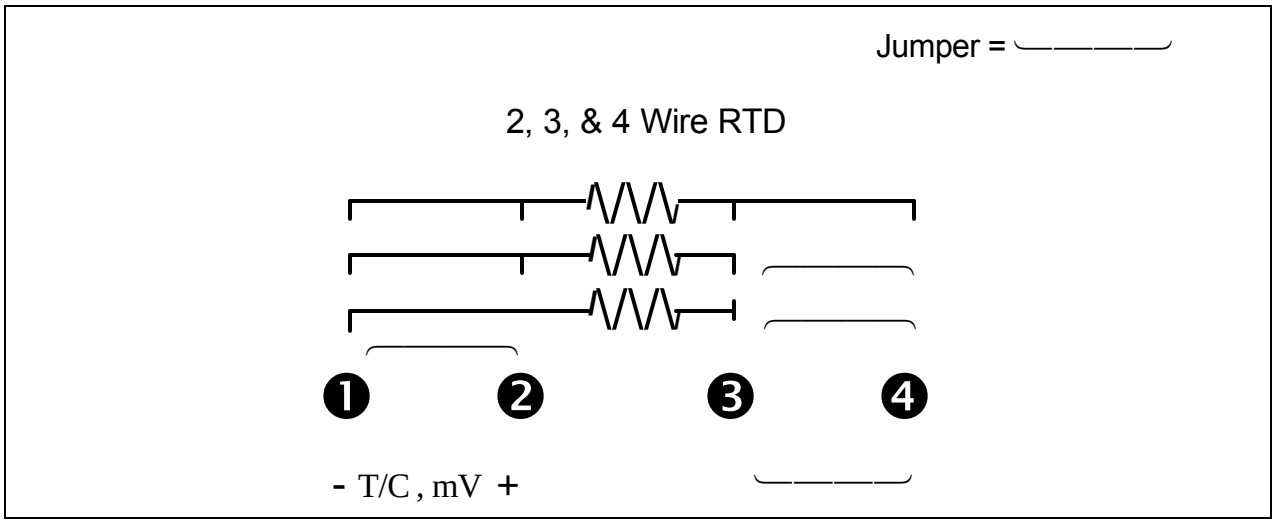


Figure 2-5 Input Terminal Connections

2.321 Millivolt and Thermocouple Input

Apply signal to terminals 1 and 2. Terminal 1 is the negative and Terminal 2 is the positive. Terminals 3 and 4 must be jumpered together for proper operation as well as to prevent any build-up of electrostatic charge on these terminals which could affect the transmitter readings.

2.322 Two-Wire RTD Input

Apply signal to terminals 1 and 3. Jumpers must be installed on terminals 1 and 2 as well as on 3 and 4 for proper operation and to prevent any build-up of electrostatic charge on these terminals which could affect the transmitter readings.

2.323 Three-Wire RTD Input

Apply the common legs from the RTD (generally the same color RTD leads) to terminals 1 and 2. Apply the other signal lead to terminal 3. Terminals 3 and 4 must be jumpered together for proper operation and to prevent any build-up of electrostatic charge on these terminals which could affect the transmitter readings.

2.324 Four-Wire RTD Input

Apply one set of the common legs from the RTD (generally the same color RTD leads) to terminals 1 and 2. Apply the other signal lead pair to terminals 3 and 4. No jumpers should be used for a 4 wire RTD input.

3.0 TRANSMITTER OPERATION

3.1 In a hurry?

When in a hurry, this short set of instructions and references will help get the transmitter running.

3.11 Factory Configuration

Input	=	*Type J Thermocouple*
Output	=	*Analog*
4.00mA	=	*40°F*
20.00mA	=	*200°F*
Sensor Fail-safe	=	*23.00mA (High)*

On special request the factory will set the transmitter to any desired configuration. Special configurations are identified on a tag attached to the unit.

3.12 Operation Without a Display

If the unit was ordered with the standard factory configuration, the sensor required is a Type J thermocouple. The packing slip and a tag on the unit will indicate if the unit was set up to any other customer requested special configuration. If there is a need to change the configuration of the transmitter, or to re-range it, use either the DK-1 or DK-2 Display / Keyboards and refer to the procedures described in *SECTIONS 4 (for DK-2) or 5 (for DK-1).*

> ***NOTE:*** *Even when "In a Hurry", the use of an appropriate power supply is important. A 24V DC supply having a current handling capacity of at least 0.1A is commonly used. Always use a DC (direct current) supply, or suitable size battery.* **Never connect the transmitter directly to 115VAC.**

With the power supply off, connect the + side of the power supply to the + terminal of the transmitter. Connect the - side of the power supply to the - terminal of the transmitter. Optionally a resistor, typically 250 ohms may be added in series with either lead.

Connect a Type J thermocouple to the transmitter input.
Thermocouple high (+) (input terminal 2)
Thermocouple low (-) (input terminal 1)
Jumper terminals 3 & 4 together

Unlike conventional electrical wiring, **on a J thermocouple the red lead is negative**. This should be checked and verified with the particular sensor to be used.

To connect other sensors to the input refer to *Section 2.32* for the proper sensor connections.

The output can be monitored by connecting a milliameter in series with either of the two output terminals, or by connecting a high impedance voltmeter across the optional 250 ohm resistor. Now turn on the power supply. In about 5 seconds the AI-1000 R2 loop current will settle to its normal value in the range of 4 to 20mA, unless the input terminals are open, in which case the output current will be 23.00mA. Note that for a Type J thermocouple, if 4mA = 40 °F and 20mA = 200ºF, each additional 10 °F increases the current by 1.0mA.

3.13 Operation With a Display

If the transmitter was ordered with either display option, it will have a small local LCD display module (with two integral buttons) plugged in to the top of the unit. Either display option can be ordered already installed on the AI-1000 R2 transmitter. Alternately, either display can be ordered and field installed at any time.

Having the display option as part of the transmitter does not affect its operation in the analog mode and the description of the previous section applies. However, the display option does provide some very useful local indication of the measured temperature and other diagnostic functions. Figure 3.1 indicates the arrangement of the display screen.

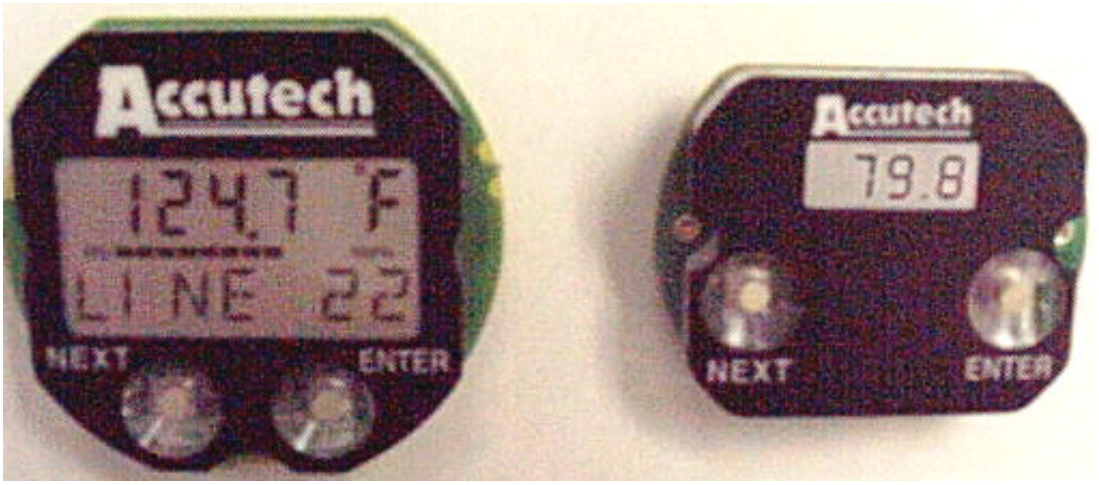


Figure 3-1 Appearance of the Local Displays, DK-2 and DK-1

In operation, the DK-1 and DK-2 displays both give the process temperature. The DK-2 provides some additional information. The DK-1 displays the process temperature and a minus sign if applicable. The temperature is displayed with a floating decimal point. For measured temperatures over 999.9° no decimal point will be displayed. Otherwise, the DK-1 will show one tenth degree increments. Unlike the more capable DK-2 display, the DK-1 does not show the units of measurement "°C", "°F", "°R", or "°K". If it is necessary to display the temperature units on the DK-1, note by hand or apply a separate label on the face of the display.

The DK-2 has more display capabilities. With the DK-2, the top display row shows the process temperature, the units of measurement, "°C", "°F", "°R", or "°K" and a minus sign if applicable. The mid portion is an analog bar graph display showing the % of range based on the ZERO and FULL SCALE setting of the transmitter. When power is applied the leftmost segment of the bar graph, the 0% and the 100% become energized momentarily. If the measured temperature is below what the ZERO is set to (below LRV), then the left arrow is energized. If the measured temperature is above the FULL SCALE setting (above URV), then the right arrow becomes energized. The bottom portion of the DK-2 display is capable of displaying an alphanumeric message up to 7 characters long. In normal operation this row shows a label, which is factory set to display "AI-1000 R2". Note that this display label can be programmed at the factory to any desired message or tag up to 7 characters.

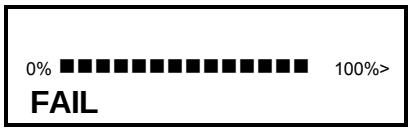
Note that the process temperature displayed on the DK-1 and DK-2 is the actual temperature as measured by the transmitter, it is not affected by the analog output range settings. This is particularly useful in startup or operation where the measured temperature is temporarily outside the normal operating range.

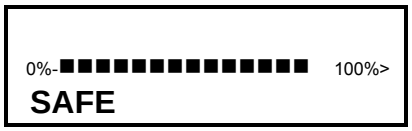
When the unit is first turned on, the display will show the measured temperature. It is frequently the case that no sensor is connected when the transmitter is first turned on. In this case, the display will show a sensor failure. In the event of a sensor or transmitter failure, the indication on the DK-1 display changes to read:

FAIL	SAFE

The words "FAIL" and "SAFE" will alternate in the display window to let you know that a failure condition has occurred.

In the event of a sensor or transmitter failure, the indication on the bottom line of the DK-2 display also changes to





The words "FAIL" and "SAFE" will alternate in the display window to let you know that a failure condition has occurred. The Percent of Output Bar Graph will indicate the output level of the transmitter. If the transmitter Failsafe Report value is set to “Fail High” (23mA), the display will be as shown, at over 100% of output. If the Failsafe Report is set to “Fail Low” (3.8mA), the Percent of Output Bar Graph would indicate the output level at under 0% of output. See sections 4.8 or 5.8 for further information on setting Failsafe Reporting.

Once the proper sensor is connected the fault message on the display should clear and the transmitter output should go to the proper value.

Both LCD displays take full advantage of the precision of these transmitters. The digital display of measurement does not include the small D/A error otherwise present in the analog output. It provides highly accurate local indication of the measurement, local fault diagnostics, and transmitter identification. The LCD continues to display the measured temperature even if it is beyond the zero and full scale limits set for the analog output. The value of this display as a set-up, calibration and reconfiguration tool may even be greater, as will be seen in later chapters.

If you should desire to change the sensor input or to re-range or reconfigure the transmitter, please refer to Sections 4 or 5 of this manual, which show you how to set-up the transmitter with the DK-1or DK-2 displays.

4.0 CONFIGURATION USING THE DK-2, TWO-LINE DISPLAY

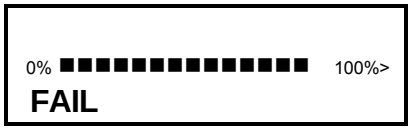
To configure a transmitter using the **DISPLAY MODE**, either the DK-1 or DK-2 local LCD display is required. These displays are available as an option and can be plugged into the top of the AI-1000 R2 transmitter. The transmitter can also be purchased with these options already installed. These inexpensive options make the reconfiguration, or re-ranging of the transmitter very simple and easy to follow. Without the use of a calibrator, or any other tools, the transmitter can be set up for a different sensor, or the new range limits can be set much like one would set the time on a digital watch.

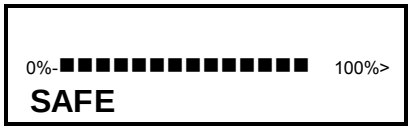
In the event that the DK-1 or DK-2 Display / Keyboard are not purchased at the same time as the transmitter, the one piece display design allows for easy field installation by simply plugging the DK-1 or DK-2 into the top of the transmitter.

4.1 Entering the Display Mode

To start the **DISPLAY MODE**, first connect the transmitter to an appropriate DC power supply. Typically a 24VDC supply is connected with the **+** side of the power supply connected to the transmitter's output "+" terminal and **-** side of the power supply connected to the transmitter's output "-" terminal. A series resistor in the loop is optional. A sensor may be connected to the transmitter's input terminals, but this is not required for setting up the transmitter.

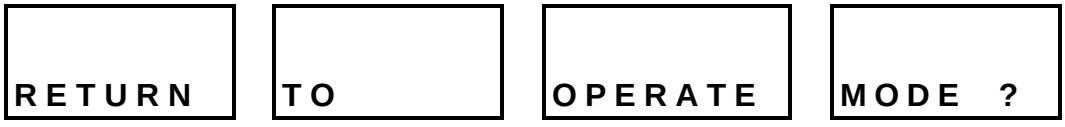
With the standard factory set-up and no sensor connected, the DK-2 display will give the following indication:





The transmitter is alternating the words FAIL SAFE, since no sensor is connected, and the analog output is indicating greater than 100%, loop current at 23.00mA, which is the standard Failsafe report condition. Please note that the display / keyboards can be plugged into the transmitter while the transmitter is powered up. There is no need to disconnect power before plugging the DK-1 or DK-2 into the AI-1000 R2.

Press the key marked **NEXT**. The display starts to alternate asking if the user wishes to return to the Operate Mode?



To activate the **NEXT** and **ENTER** keys, a slow, deliberate push of the key is required. This prevents any casual, inadvertent activation of the transmitter into one of the configuration modes.

The answer would be "No", therefore, press the **NEXT** key. This will enter you into the **DISPLAY MODE** configuration menu. If you wish to answer a question "Yes", press the **ENTER** KEY. A flow chart summarizing the operation of the **DISPLAY MODE** appears at the end of this manual.

Note that when more than seven characters are required to describe a function, the display keeps sequencing through two or more screens or may use common abbreviations. In this manual, the sequencing of the display is indicated by placing the two or more parts of the message adjacently. With some functions, the DK-2 display indicates a numeric value and unit of measurement on the top line of the display in addition to the message on the lower display line.

4.2 Display Mode Configuration

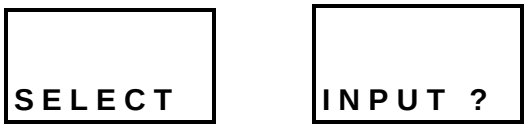
The **DISPLAY MODE** will allow the user to do the following:

- Select a Sensor Input (SELECT INPUT)
- Select a desired temperature unit, such as ºF (SELECT UNITS)
- Change the 4mA Lower Range Value (CHANGE ZERO)
- Change the 20mA Full Scale Value (CHANGE FULL SCALE)
- Change the Sensor Fail Safe detection (SELECT SENSOR FAIL SAFE)
- Change the Fail Safe reporting (SELECT FAIL SAFE REPORT)
- Trim the 4.0mA output current (TRIM 4 MA)
- Trim the 20.0mA output current (TRIM 20 MA)
- Trim the display value (TRIM DISPLAY)

Each of these functions is presented in sequence on the LCD display. If the indicated function need not be performed, press **NEXT**, and the next function is displayed on the screen. To perform any function press the **ENTER** key. This will cause additional screens to be displayed which enable you to perform the function. These are described in detail below and summarized on the DK-2 Two-Line Display / Keyboard Flowchart found in the rear of this manual.

4.3 Select a Sensor Input

The **SELECT SENSOR** is the first function in the sequence. Virtually any thermocouple, RTD or millivolt input can be selected. The display will read as follows to indicate this position on the menu:



If the sensor is set correctly, press **NEXT** and skip to Section 4.4 of this manual; otherwise press **ENTER**. After pressing the **ENTER** key, the display will change to:

Indicating that the transmitter is set to a Type J thermocouple input. If this is the desired sensor, then press **ENTER**, otherwise press **NEXT** repeatedly to sequence through the available sensors. Each time **NEXT** is pressed, the next available sensor selection is displayed.

Press the **NEXT** key to go the next sensor

Press the **NEXT** key to continue through the different sensor selections

Note: The T/C SPEC or Special Thermocouple input is reserved for a special thermocouple input, should one be desired. This Special must be ordered from the factory.

Note: This is the 100Ω Platinum DIN Curve with α = 0.00385.

Note: This is the 100Ω SAMA Platinum Curve, known variously as the SAMA RC21-4 or SAMA PR-279. Constants are 98.13Ω @ 0°C, α=0.003923.

Note: The 2W SPEC or Special 2 wire RTD input is reserved for a special RTD input, should one be desired. Any special 2-wire RTD curve must be ordered from the factory.

Note: This is the 100Ω Platinum DIN Curve with α = 0.00385.

Note: This is the 100Ω SAMA Platinum Curve, known variously as the SAMA RC21-4 or SAMA PR-279. Constants are 98.13Ω @ 0°C, α=0.003923.

Note: The 3W SPEC or Special 3 wire RTD input is reserved for a special RTD input, should one be desired. Any special 3-wire RTD curve must be ordered from the factory.

Note: This is the 100Ω Platinum DIN Curve with α = 0.00385. This sensor will give superior measurement results in most real-world situations where the measured temperature is under 1,000ºF.

Note: This is the 100 Ω SAMA Platinum Curve, known variously as the SAMA RC21-4 or SAMA PR-279. Constants are 98.13Ω @ 0°C, α=0.003923.

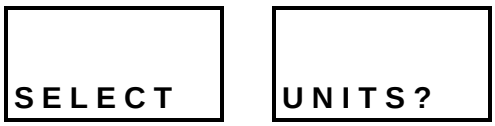
Note: The 4W SPEC or Special 4 wire RTD input is reserved for a special RTD input, should one be desired. Any special 4-wire RTD must be ordered from the factory.

Note: The HHTONLY is for a Hand-Held set-up. This is used for Factory set-up only.

Pressing **NEXT** key again returns you to the J thermocouple selection. Repeated pressing of **NEXT** key will again cycle you through the input selection submenu. You can stop at any one of the thermocouple, RTD or mV selections by pressing the **ENTER** key. This action changes the transmitter mode to that sensor. If no sensor change is desired, then, without sequencing through the various sensor options, but just pressing the **ENTER** key will allow one to confirm the sensor selection and leave it unchanged. Assume that the sensor is left as T/C J. After pressing **ENTER** the display will return to the main menu entry of **SELECT INPUT**. Pressing the **NEXT** key then takes the transmitter to the next main menu selection.

4.4 Select Units

If the selected sensor is a thermocouple or RTD, the next menu entry is **SELECT UNITS**.



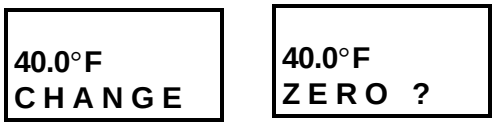
Pressing the **ENTER** key displays the current units

By repeatedly pressing the **NEXT** key, the display will sequence through the following screens:

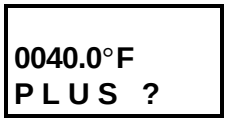
These correspond to K=Kelvin, R=Rankine, C=Celsius and F=Fahrenheit. Stopping the selection at any one of these units and then pressing **ENTER** will set the transmitter to the corresponding new units. For the purposes of this example the units of measure can be left at DEG F by pressing **ENTER**. Advancing the menu selection with the **NEXT** key lets you change the zero.

4.5 Change Zero

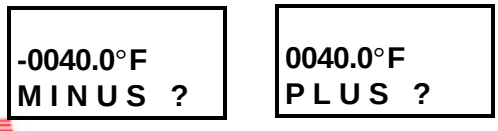
The display will then alternate between the following screens to indicate that one may now change the zero, or 4mA output point. The numeric value seen on the upper portion of the screen is the ZERO value of the transmitter. One can now change this ZERO, or LOWER RANGE VALUE, (LRV), totally independent of the FULL SCALE, or UPPER RANGE VALUE, (URV), without the use of any calibrators or external sensor inputs.



To change the ZERO, press **ENTER**. The display changes to read:



indicating that the existing ZERO is set to "plus" 0040.00ºF. The question mark "?" indicates a question asking if this value is to remain positive (PLUS ?). By repeatedly pressing the **NEXT** key the display will alternate:



After deciding whether the ZERO value, LRV, is to remain positive (PLUS), press the **ENTER** key. In this example assume it is to remain positive. The display changes to read:

and the leftmost digit position will start blinking (shown here in italics) asking if the thousands position needs to be changed. To change the thousands position, start pressing the **NEXT** key and the leftmost digit will increment through 1 2 3 4 5 6 7 8 9 0. Stop pressing the **NEXT** key at the desired numeral, then press **ENTER** to accept the selection. If the numeral selected before pressing **ENTER** was 0, then the display would change to read:

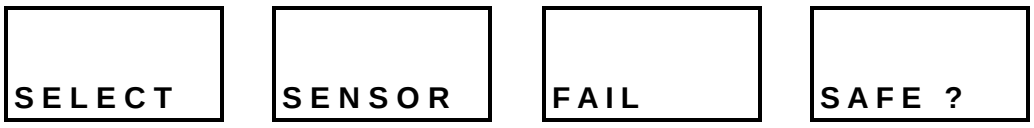
and the second digit from the left will start blinking (shown here in italics) asking if the hundreds position needs to be changed. As before, to change the number in this digit position repeatedly press the **NEXT** key until the desired numeral is reached. Then press **ENTER** to go to the next lower significant digit position. Each time the **NEXT** key cycles through the ten choices for that digit position and the **ENTER** key enters the selected number. The digit position being changed is the one that is blinking. The legend on the display will change successively to read:

After the tenth's digit position has also been changed to the desired value, the next pressing of the **ENTER** key returns the transmitter to the alternating display of **CHANGE ZERO**. Since changing of the zero has just been completed, press the **NEXT** key to proceed to the next menu selection, **CHANGE FULL SCALE.**

4.6 Change Full Scale

To change the full scale value press **ENTER**. The procedure for selecting Plus or Minus is identical to that described for changing the ZERO. Similarly, the procedure for changing each of the digit positions is identical to that described for changing the ZERO. Once the steps of changing the FULL SCALE have been completed and the **ENTER** key is pressed at the end of the procedure, the display returns to **CHANGE FULL SCALE**. Press **NEXT** for the next function **SELECT SENSOR FAIL SAFE DETECTION**.

4.7 Select Sensor Fail-Safe Detection



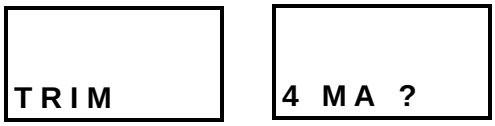
If you want to change the **SENSOR FAIL SAFE** detection press **ENTER**. The present status of the **SENSOR FAIL SAFE** is displayed. It is recommended that one turns off the Sensor failsafe System when using the AI-1000 R2 with an input simulator. It should then be turned on when reconnecting the transmitter to the actual sensor.

When the desired fail-safe condition is displayed, pressing the **ENTER** key will change to the new setting and the screen returns to the **SELECT SENSOR FAIL SAFE** display. Pressing the **NEXT** key will bring up the **FAIL SAFE REPORTING** selection screen.

4.8 Select Fail-Safe Reporting

Fail-safe reporting allows the transmitter to change the 4-20mA loop to indicate a failure condition. This failure may be a sensor failure or a transmitter failure. In any event, the user may select to drive the loop to 23.0mA, corresponding to the “HI” selection; or 3.6mA, corresponding to the “LO” selection or to turn the function “OFF”.

4.9 Trim 4.0mA

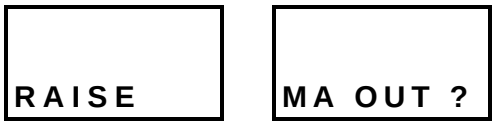


This allows trimming of the 4.00mA output current.

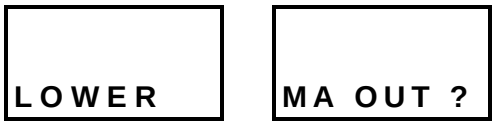
> ***Note:*** *This function is only for the purpose of adjusting the 4.00mA limit of the transmitter loop current to be exactly 4.00mA according to the plant's local standard. This is* ***NOT*** *for the purpose of ranging the transmitter!*

If trimming the 4.00mA limit is still desired then press **ENTER**. The transmitter will now output a milliamp current equal to its internally set 4mA. This 4mA value should be read on an external meter and compared to a local standard. It is advisable to use a very good voltmeter to make these comparisons. It is very possible that the transmitter will be more accurate than a great many voltmeters. In this case, trimming will make the transmitter less accurate rather than more accurate!

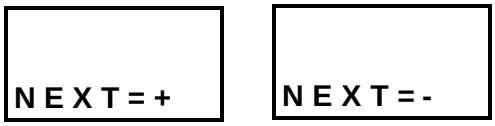
Once trimming the 4.00mA value has been selected, the display will alternate as follows:



By pressing the **NEXT** key the display then alternates:



When it is decided whether to raise or lower the output current, then press **ENTER** and the display changes to one of the following depending on whether the raise or lower function has been selected.

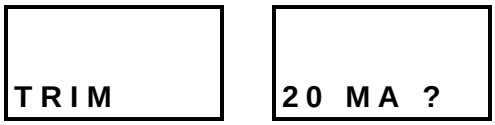


Now every time the **NEXT** key is pressed, the display blinks, and the 4.0mA output limit decreases (-), or increases (+). The decrease or increase is in approximately 3.5 micro ampere increments.

> ***Note:*** *The 4.00mA limit is factory calibrated to a precision standard. Using the Output Trim function voids the NIST traceability of calibration. Do not arbitrarily trim the output unless a qualified and accurate local standard is available to measure the adjusted 4.00mA output! Also note that the 4.0mA limit should not be trimmed by more than about ±50mA, or transmitter operation may be impaired.*

Once the desired trim is reached, pressing **ENTER** will return to one of the corresponding **TRIM 4MA** screen. At this point one may still go back and do further trimming of the 4.0mA limit by pressing the **ENTER** key, or pressing the **NEXT** key changes to the next function.

4.10 Trim 20.0 mA



Trimming of the 20.0mA current limit is done in exactly the same manner as was described for trimming the 4.0mA point. The same precautions apply. After completing the trim 20.0mA pressing the **NEXT** key brings up the display trim.

4.11 Trim Display

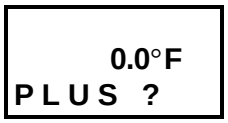
The display trim allows the display to be trimmed by a desired offset amount. The transmitter display will display its value based upon its internal standards. It is often desirable to alter this display to make it agree with another external instrument at a critical measurement point. If this is desirable, the display can be trimmed. The display trim operates as a zero shift. It shifts the display readings by the same amount at every point. Multiple point corrections up to 22 points are possible from the factory.

Note : If a multiple point calibration curve is entered by the factory, the TRIM DISPLAY function will not appear as a menu option in DISPLAY MODE.

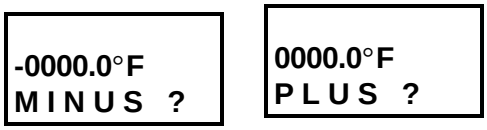
You can enter a single point offset to the display. Be certain before making a display trim correction that you have made good electrical connections to the transmitter and the sensor. In the 2 or 3 wire RTD input, or thermocouple input modes, it is possible to produce an error of a few degrees with a fraction of an ohm in any one of the connections. Please be careful when tightening down the input connections. These can be easily broken if alot of torque is applied. The idea is to make a good electrical connection without breaking the connections. When you press the **ENTER** key the display changes to:

You can now enter an offset to the display. Suppose that the display reads 530ºF, at a time when an external device that you want to agree with reads 525ºF. You would then want to enter a -5ºF offset in the display trim. This is done exactly the same way as setting the zero and full-scale values.

The numeric value seen on the upper portion of the screen is the existing Display Trim Value. Normally this is set to zero. One can now change this Offset totally independent of the ZERO, or LOWER RANGE VALUE, (LRV) or the FULL SCALE, or UPPER RANGE VALUE, (URV), without the use of any calibrators or external sensor inputs. To change the display offset, press **ENTER**. The display changes to:



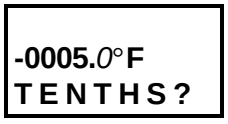
indicating that the existing OFFSET is set to "plus" 0000.0ºF. The question mark "?" indicates a question asking if this value is to remain positive (PLUS ?). By repeatedly pressing the **NEXT** key the display will alternate



After deciding whether the OFFSET VALUE is to become negative (MINUS), press the **ENTER** key. In this example the offset is assumed to be negative and a minus sign will be carried through this example. The display then changes to read:

The leftmost digit position will start blinking (shown here in italics) asking if the thousands position needs to be changed. To change the thousands position, start pressing the **NEXT** key and the leftmost digit will increment through 1 2 3 4 5 6 7 8 9 0. Stop pressing the **NEXT** key at the desired numeral, then press **ENTER** to accept the selection. If the numeral selected before pressing **ENTER** was 0, then the display would change to

and the second digit from the left will start blinking (shown here in italics) asking if the hundreds position needs to be changed. As before, to change the number in this digit position repeatedly press the **NEXT** key until the desired numeral is reached. Then press **ENTER** to go to the next lower significant digit position. Each time the **NEXT** key cycles through the ten choices for that digit position and the **ENTER** key enters the selected number. The digit position being changed is the one that is blinking. The legend on the display will change successively to:



After the tenths digit position has also been changed to the desired value, the next pressing of the **ENTER** key returns the transmitter to the alternating display of **TRIM DISPLAY**. Since changing of the offset value has just been completed, press the **NEXT** key to proceed to the next menu selection. Note, if trimming the transmitter to external devices is desirable, it may be necessary to trim the 4 and 20mA output **after** setting the display offset. After completing the trim display function, pressing the **NEXT** key brings up Select Language.

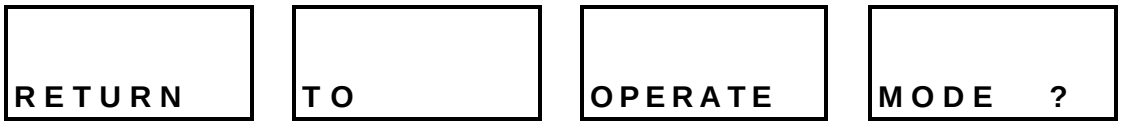
4.12 Select Language

The Select Language function allows the user to configure the transmitter in any of four different languages. English, German, French and Spanish language menu options are available. When you press the **ENTER** key the display changes to:

indicating that the current language setting is English. By pressing the **NEXT** key the display changes to read:

By repeatedly pressing the **NEXT** key, the display will sequence through the following screens:

After deciding which language you would like the transmitter to be set for, press the **ENTER** key. The display then changes to read:



If all of the set-up and re-ranging operations have been satisfactorily completed, then pressing **ENTER** will return the transmitter to the normal operate mode. Pressing the **NEXT** key at this point will return the display to the first screen in the sequence, SELECT INPUT.

Note again, that whenever the transmitter is in the display set-up mode, if no activation of the pushbuttons occur for approximately 2½ minutes, the transmitter returns to the operate mode. One can also return to the operate mode at any point while in the **DISPLAY MODE** by removing power from the transmitter for about 10 seconds, then reapplying power.

5.0 CONFIGURATION USING THE DK-1, ONE-LINE DISPLAY

To configure a transmitter using the **DISPLAY MODE**, either the DK-1 or DK-2 local LCD display is required. These displays are available as an option and can be plugged into the top of the AI-1000 R2 transmitter. The transmitter can also be purchased with these options already installed. These inexpensive options make the reconfiguration, or re-ranging of the transmitter very simple and easy to follow. Without the use of a calibrator, or any other tools, the transmitter can be set up for a different sensor, or the new range limits can be set much like one would set the time on a digital watch.

In the event that the DK-1 or DK-2 Display / Keyboard are not purchased at the same time as the transmitter, the one piece display design allows for easy field installation by simply plugging the DK-1or DK-2 into the top of the transmitter.

5.1 Entering the Display Mode

To start the **DISPLAY MODE**, first connect the transmitter to an appropriate DC power supply. Typically a 24VDC supply is connected with the "**+**" side of the power supply connected to the transmitter's output "**+**" terminal and the "-" side of the power supply connected to the transmitter's output "**-**" terminal. A series resistor in the loop is optional. A sensor may be connected to the transmitter's input terminals, but this is not required for setting up the transmitter.

With the standard factory set-up and no sensor connected, the DK-1 display will give the following indication:

FAIL	SAFE

The transmitter is indicating a fault. This would be the proper indication, since there is no sensor connected. The analog output would indicate greater than 100% (loop current at 23.00mA), which is the standard over range condition. If the proper sensor were connected to the transmitter, the display would indicate the sensor's temperature. Please note that the display / keyboards can be plugged into the transmitter while the transmitter is powered up. There is no need to disconnect power before plugging the DK-1 or DK-2 into the AI-1000 R2.

Press the key marked **NEXT** to begin scrolling through the DISPLAY MODE menus.

9900

The **9900** code corresponds to the **Return to Operate Mode** function. At this point, assuming one does not want to return to the operate mode, the answer should be no, therefore, press the key marked **NEXT**. Pressing the key marked **ENTER** at this point will return the transmitter to the operate mode.

5.2 Display Mode Operation

The one-line, DK-1 display will allow the user to do the following in a manner similar to the two-line display.

- Select a Sensor Input (SELECT INPUT)
- Select a desired temperature unit, such as ºF or ºC (SELECT UNITS)
- Change the 4mA Lower Range Value (CHANGE ZERO)
- Change the 20mA Full Scale Value (CHANGE FULL SCALE)
- Change the Sensor Fail Safe detection (SELECT SENSOR FAIL SAFE)
- Change the Fail Safe reporting (SELECT FAIL SAFE REPORT)
- Trim the 4.0mA output current (TRIM 4 MA)
- Trim the 20.0mA output current (TRIM 20 MA)
- Trim the display value (TRIM DISPLAY)

Each of these functions is presented with a code in a prescribed sequence on the LCD display. If the indicated function need not be performed, press **NEXT**, and the next function will be displayed on the screen. To perform any function press the **ENTER** key. This will cause additional screens to be displayed which enable you to perform the function. These are described in detail below and summarized in the DK-1 One-Line Display / Keyboard Flowchart found at the rear of this manual.

5.3 Select a Sensor Input

The **SELECT INPUT** is the first function in the sequence. Virtually any thermocouple, RTD or millivolt input can be selected. The display will read as follows to indicate this position on the menu:

9 0 0 0

The factory default sensor input is a J thermocouple. If the sensor does not require changing, then press **NEXT**, and skip to Section 5.4 of this manual; otherwise press **ENTER**. After pressing the **ENTER** key, the display will change to:

9 0 0 4

Indicating that the transmitter is set to a Type J thermocouple input. If this is the desired sensor, then press **ENTER**, otherwise press **NEXT** repeatedly to sequence through the available sensors. Each time **NEXT** is pressed, the next available sensor selection is displayed.

9 0 0 4

The 9004 Code corresponds to a J thermocouple.

9 0 0 5

The 9005 Code corresponds to a K thermocouple.

9 0 0 6

The 9006 Code corresponds to an L thermocouple.

9 0 0 7

The 9007 Code corresponds to an N thermocouple.

9 0 0 8

The 9008 code corresponds to an R thermocouple.

9 0 0 9

The 9009 code corresponds to an S thermocouple.

9 0 1 0

The 9010 code corresponds to a T thermocouple.

9 0 1 1

The 9011 code corresponds to a U thermocouple.

9012

Note: The 9012, T/C SPEC or Special Thermocouple input is reserved for a special thermocouple input, should one be desired. This special curve must be ordered from the factory.

9013

The 9013 code corresponds to a 2-wire ohm input.

9014

The 9014 code corresponds to a 2-wire 100 Ω DIN curve platinum RTD with an α = 0.00385.

9015

The 9015 code is the 2-wire 100Ω SAMA Platinum Curve, known variously as the SAMA RC21-4 or SAMA PR-279.

9016

The 9016 code is reserved for a Special 2 wire RTD, should one be desired. Any special 2-wire RTD curve must be ordered from the factory.

9017

The 9017 code is for 3-wire Ohms.

9018

The 9018 code is for a 3-wire 100Ω DIN curve RTD with α = 0.00385. This is the most commonly used RTD in industrial applications.

9019

The 9019 code is the 3-wire 100Ω SAMA Platinum Curve, known variously as the SAMA RC21-4 or SAMA PR-279.

9020

The 9020 code for the Special 3 wire RTD input is reserved for a special RTD input, should one be desired. Any special 3-wire RTD curve must be ordered from the factory.

9 0 2 1

The 9021 code is for a 4 wire Ohm input.

9 0 2 2

The 9022 code is for a 4-wire 100Ω DIN curve Platinum RTD with α = 0.00385. This sensor will give superior measurement results in most real-world situations where the measured temperature is under 1,000ºF.

9 0 2 3

The 9023 code is the 4-wire 100Ω SAMA Platinum Curve, known variously as the SAMA RC21-4 or SAMA PR-279.

9 0 2 4

Note, the 9024 code is for Special 4 wire RTD input is reserved for a special RTD input, should one be desired. Any special 4-wire RTD curve must be ordered from the factory.

9 0 2 5

The 9025 code corresponds to a millivolt input.

9 0 2 6

The 9026 code corresponds to an input known as the "HHTONLY". This is reserved for a Hand-Held set-up at the factory only.

At this point, the menus recycle to the top and begin with the first sensor input.

9 0 0 1

The 9001 code corresponds to a B type thermocouple.

9 0 0 2

The 9002 code corresponds to a C type thermocouple.

9 0 0 3

The 9003 code corresponds to an E type thermocouple.

You can stop at any one of the thermocouple, RTD or mV selections by pressing the **ENTER** key. This action changes the transmitter mode to that sensor. If no sensor change is desired, then, without sequencing through the various sensor options, but just pressing the **ENTER** key will allow one to confirm the sensor selection and leave it unchanged. Assume that the sensor is left as T/C J. After pressing **ENTER** the display will return to the main menu entry of SELECT INPUT. Pressing the **NEXT** key then takes the transmitter to the next main menu selection.

5.4 Select Units

If the selected sensor is a thermocouple or RTD, the next menu entry is **SELECT UNITS**. You will not see this selection if an ohms or mV input selection is made.

9 1 0 0

The code **9100** corresponds to the **SELECT UNITS** entry in the main menu. Pressing the **ENTER** key takes you to this section of the menu. This screen indicates that the transmitter is currently set to degrees F. Pressing the **NEXT** key, the display will sequence through the following screens:

9 1 3 3

The 9133 code corresponds to units of Degrees Fahrenheit.

9 1 3 4

The 9134 code corresponds to units of Degrees Rankine.

9 1 3 5

The 9135 code corresponds to units of Degrees Kelvin.

9 1 3 2

The 9132 code corresponds to units of Degrees Centigrade.

Stopping the selection process on the DK-1 display at any one of these units and then pressing **ENTER** will set the transmitter to the corresponding new units. For the purposes of this example the units of measure can be left at DEG F by pressing **ENTER**. Pressing the **NEXT** key will bring you to the next section of the menu, changing the Zero.

5.5 Change Zero (Lower Range Value)

The display will then read as follows to indicate that one may now change the zero, or 4mA output point.

9 2 0 0

The code **9200** indicates that one can now change this ZERO, or LOWER RANGE VALUE (LRV), totally independent of the FULL SCALE, or UPPER RANGE VALUE, (URV), without the use of any calibrators or external sensor inputs. To change the ZERO, press **ENTER**. The display changes to:

9 2 0 1

The 9201 code indicates that a positive, or "plus", number is selected for the 4 mA (LRV) output point. By repeatedly pressing the **NEXT** key the display will alternate:

9 2 0 2

The 9202 code corresponds to a negative number to be selected for the 4mA output point. After deciding whether the ZERO value, or LRV, is to remain positive (PLUS), press the **ENTER** key. In this example assume it is to remain positive. The display changes to read:

*0*0040

and the leftmost digit position will start blinking (shown here in italics) asking if the thousands position needs to be changed. To change the thousands position, start pressing the **NEXT** key and the leftmost digit will increment through 1 2 3 4 5 6 7 8 9 0. Stop pressing the **NEXT** key at any of the numerals desired, then press **ENTER** to accept the selection. If the numeral selected before pressing **ENTER** was 0, then the display would change to read:

0*0*040

The second digit from the left will start blinking (shown here in italics) asking if the hundreds position needs to be changed. As before, to change the number in this digit position repeatedly press the **NEXT** key until the desired numeral is reached. Then press **ENTER** to go to the next lower significant digit position. Each time the **NEXT** key cycles through the ten choices for that digit position and the **ENTER** key enters the selected number. The digit position being changed is the one that is blinking. The legend on the display will change successively to read:

00*4*0

004*0*

After the one's digit position has also been changed to the desired value, the next pressing of the **ENTER** key returns the transmitter to the alternating display of **CHANGE ZERO**. Since changing of the zero has just been completed, press the **NEXT** key to proceed to the next menu selection, **CHANGE FULL SCALE.**

5.6 Change Full Scale (Upper Range Value)

9300

The code **9300** corresponds to selection **CHANGE FULL SCALE**, or UPPER RANGE VALUE (URV). To change the full scale value press **ENTER**. The procedure for selecting Plus or Minus is identical to that described for changing the ZERO, with the code 9301 corresponding to a positive (+) number and the code 9302 corresponding to a negative (-) number. The procedure for changing each of the digit positions is identical to that described for changing the ZERO. Once the steps of changing the FULL SCALE have been completed and the **ENTER** key is pressed at the end of the procedure, the display returns to **CHANGE FULL SCALE**. Press **NEXT** for the next function **SELECT SENSOR FAIL SAFE DETECTION**.

5.7 Select Sensor Fail Safe Detection

9 4 0 0

The code **9400** corresponds to selecting the SENSOR FAIL-SAFE detection. If one desires to change the **SENSOR FAIL SAFE** detection then press **ENTER**. The present status of the Sensor Fail-safe is displayed. It is recommended that one turns off the Sensor fail-safe when using the AI-1000 R2 with an input simulator. It should then be turned on when reconnecting the transmitter to the actual sensor.

9 4 0 1

The code 9401 indicates that the sensor fail-safe detection is turned on.

9 4 0 2

The code 9402 indicates that the sensor fail-safe detection is turned off. When the desired fail-safe condition is displayed, pressing the **ENTER** key will change to the new setting and the screen returns to the **SELECT SENSOR FAIL SAFE** display, code 9400. Pressing the **NEXT** key will then bring up the **FAIL SAFE REPORT** selection screen.

5.8 Select Fail Safe Reporting

The code **9500** indicates the main menu entry for setting the transmitter **FAIL-SAFE REPORT**. Pressing the **ENTER** key will bring up the following code:

9 5 0 1

The code 9501 corresponds to instructing the transmitter to output 3.6mA under a fail-safe condition. Pressing the **ENTER** key at this point sets the fail-safe **LOW**. Pressing the **NEXT** key brings up the following screen:

9 5 0 2

The code 9502 corresponds to instructing the transmitter to output 23.0mA under a fail-safe condition. Pressing the **ENTER** key at this point sets the fail-safe **HIGH**. Pressing the **NEXT** key brings up the following screen:

9 5 0 3

The code 9503 corresponds to instructing the transmitter to not report a fail-safe condition. Pressing the **ENTER** key at this point turns off this reporting. Pressing the **NEXT** key brings up the next function, **TRIM 4 MA**.

5.9 Trim 4.0mA

The code **9600** indicates the main menu entry for performing an **4 MA OUTPUT TRIM**. Pressing the **ENTER** key will bring up the following code.

9 6 0 0

This function will trim the 4.00mA output current of the transmitter.

> ***Note:*** *The 4.00mA limit is factory calibrated to a precision standard. Using the Output Trim function voids the NIST traceability of calibration. Do not arbitrarily trim the output unless a qualified and accurate local standard is available to measure the adjusted 4.00mA output! Also note that the 4.0mA limit should not be trimmed by more than about ±50mA, or transmitter operation may be impaired.*

If trimming the 4.00mA limit is still desired then press **ENTER**. The transmitter will now output a milliamp current equal to its internally set 4mA. This 4mA value should be read on an external meter and compared to the plant standard. It is advisable to use a very good voltmeter to make these comparisons. It is very possible that the transmitter will be more accurate than a great many voltmeters. In this case, trimming will make the transmitter less accurate rather than more accurate!

Once trimming the 4.00mA value has been selected, the display will show:

9 6 0 1

The code 9601 corresponds to selecting the function to raise mA output.

Pressing the **NEXT** key the display then shows:

9 6 0 2

The code 9602 corresponds to selecting the function to lower the mA output. Comparing the transmitter output to the external device will allow you to decide whether to raise or lower the milliamp value. When it is decided whether to raise or lower the output current, then press **ENTER** and the display changes to one of the following depending on whether the raise or lower function has been selected.

9 6 1 0	9 6 2 0
(raises output)	(lowers output)

The code 9610 confirms that you are in the Raise 4mA output trim function. Each time the **NEXT** key is pressed, the display blinks, and the 4.0mA output limit increases (+). The increase is in approximately 3.5 micro-ampere increments. The code 9620 confirms that you are in the Lower 4mA output trim. Each time the **NEXT** key is pressed, the display blinks, and the 4.0mA output limit decreases (-). The decrease is in approximately 3.5 micro-ampere increments.

> ***Note:*** *The 4.00mA limit is factory calibrated to a precision standard. Using the Output Trim function voids the NIST traceability of calibration. Do not arbitrarily trim the output unless a qualified and accurate local standard is available to measure the adjusted 4.00mA output! Also note that the 4.0mA limit should not be trimmed by more than about ±50mA, or transmitter operation may be impaired.*

Once the desired trim is reached, pressing **ENTER** will return to the corresponding TRIM 4MA screen. At this point one may still go back and do further trimming of the 4.0mA limit by pressing the **ENTER** key, pressing the **NEXT** key changes to the next function.

5.10 Trim 20mA

The code **9700** indicates the main menu entry for setting the performing a **20MA OUTPUT TRIM**. Pressing the **ENTER** key will bring up the following code:

9 7 0 0

This function will trim the 20.00mA output current of the transmitter.

Trimming of the 20.0mA current limit is done in exactly the same manner as was described for trimming the 4.0mA point. Similarly the same precautions apply. The code 9701 corresponds to selecting the function to raising the mA output. The code 9702 corresponds to selecting the function to lower the mA output. The code 9710 confirms raising the 20mA output by approximately 3.5 micro-ampere increments with each push of the **NEXT** key. The code 9720 confirms lowering the 20mA output by approximately 3.5 micro-ampere increments with each push of the **NEXT** key. After completing the trim 20.0mA pressing the **NEXT** key brings up the **TRIM DISPLAY** menu.

5.11 Trim Display

The display trim allows the display to be trimmed to a desired point. The transmitter's DK-1 or DK-2 display will show its value based upon the transmitter's current settings. It is often desirable to alter the display to make it agree with another instrument at a critical measurement point. If this is desirable, the display can be trimmed. The display trim operates as a zero shift and shifts the display readings by the same amount at every point. Multiple point corrections up to 22 points are available from the factory.

Note : If a multiple point calibration curve is entered by the factory, the TRIM DISPLAY function will not appear as a menu option in DISPLAY MODE.

You can enter a single point offset to the display. Be certain before making a display trim correction that you have made good electrical connections to the transmitter and the sensor. In the 2 or 3 wire RTD input, or thermocouple input modes, it is possible to produce an error of a few degrees with a fraction of an ohm in any one of the connections. Please be careful when tightening down the input connections. These can be easily broken if alot of torque is applied. The idea is to make a good electrical connection without breaking the connections.

The display trim allows you to enter an offset correction. For example, suppose that the display reads 530ºF, at a time when an external device that you want to agree with reads 525ºF. You would then want to enter a -5ºF offset in the display trim. This is done exactly the same way as setting the zero and full-scale values. Pressing the **NEXT** key at this point advances the menus and the display will now read:

The 9800 code corresponds to the display trim.

9800

One can set the display trim offset by pressing the **ENTER** key. The display changes to:

9801

The 9801 code indicates that a "plus" number is selected for the display offset. By repeatedly pressing the **NEXT** key the display will alternate:

9801	**9 8 0 2**

the 9802 code corresponds to a negative number to be selected for the display trim point. After deciding whether the display trim value is to remain positive (PLUS), or negative (MINUS) press the **ENTER** key. In this example assume it is to be a negative offset. The display changes to:

- *0*00

and the leftmost digit position will start blinking (shown here in italics) asking if the hundreds position needs to be changed. To change the hundreds position, start pressing the **NEXT** key and the leftmost digit will increment through 1 2 3 4 5 6 7 8 9 0. Stop pressing the **NEXT** key at the desired numeral, then press **ENTER** to accept the selection. If the numeral selected before pressing **ENTER** was 0, then the display would change to:

- 0*0*0

and the second digit from the left will start blinking (shown here in italics) asking if the tens position needs to be changed. Pressing the **ENTER** key will fix the tens digit and display the ones digit:

- 00*0*

In this example, we want to enter a -5 degree offset, so we want to cycle the “ones” digit. As before, to change the number in this digit position repeatedly press the **NEXT** key until the desired numeral is reached. Then press **ENTER** to go to the next lower significant digit position. Each time the **NEXT** key cycles through the ten choices for that digit position and the **ENTER** key enters the selected number. The digit position being changed is the one that is blinking. The legend on the display will change successively to:

- 00*5*

After the ones digit position has been changed to the desired value, the next pressing of the **ENTER** key returns the transmitter to the 9800 code. Note that since the DK-1 will only display in whole degrees, the display trim is limited to whole degrees. If greater display precision is required, the two-line DK-2 display will give you precision to the tenths of degrees. Since changing of the zero has just been completed, press the **NEXT** key to proceed to the next menu selection, **RETURN TO OPERATE MODE.**

9900

If all of the set-up and re-ranging operations have been satisfactorily completed, then pressing **ENTER** will return the transmitter to the normal operate mode. Pressing the **NEXT** key at this point will return the display to the first screen in the sequence, **SELECT INPUT** which corresponds to the code 9000.

Note again, that whenever the transmitter is in the display set-up mode, if no activation of the keyboard occurs for approximately 2½ minutes, the transmitter returns to the operate mode. One can also return to the operate mode at any point in the **DISPLAY MODE** by removing power from the transmitter for about 10 seconds and then reapplying power.

6.0 APPLICATIONS INFORMATION

6.1 SENSOR FAIL-SAFE DETECTION

The AI-1000 R2 detects a sensor failure condition by making various measurements across its sensor input terminals. As a result of these measurements, the unit can detect an open thermocouple or open RTD condition. In addition, the AI-1000 R2 can detect if an RTD is short circuited, or if any of its terminal wires (2, 3, or 4-wire RTD's) are open. Any one of these conditions will cause a "FAIL-SAFE" report indication.

In the process of performing these sensor failure checks, the unit periodically passes small pulses of current through the sensor and its connecting wires. The transmitter measures the resulting voltage drop. One of the conditions resulting in a FAIL-SAFE reporting condition is if this voltage drop exceeds 180mV.

In the case of an RTD, the fail-safe detection is part of the normal excitation for the RTD and therefore both the temperature measurement and some of the sensor fail-safe detection routines are done simultaneously. In the case of a thermocouple, during the temperature measurement cycle, there is no open sensor test current in the thermocouple. Thermocouple open circuit is detected by making a second measurement with the test current through the thermocouple.

This method of testing for sensor failure has the following advantages:

1) In the case of thermocouples, there is no steady current through the sensor during measurement and therefore accuracy is not degraded.
2) During open sensor detection, the test current is sufficiently high that even if there is some leakage resistance between the sensor leads, an open sensor will be positively detected.

There are certain precautions to be observed when using this method of sensor failure detection. If the lead wire resistance is too great, then a false FAIL-SAFE report could be generated. The maximum lead wire resistance is dependent on the type of sensor being used and the maximum temperature expected to be measured. The maximum lead resistance for an RTD is 50Ω in any one lead. For a thermocouple, the maximum allowable resistance is 1,000Ω for a non-grounded junction Thermocouple and 10 Ω for a grounded junction Thermocouple.

6.2 CONFIGURATION WITH AN EXTERNAL SOURCE

With an external source, the basic procedure is to set the external source to the value you require for 4mA or 20mA. Next, read the transmitter value on the DK-1 or DK-2 display. Record these values. Then follow the display set-up procedure to set the 4mA and 20mA values to the values that you recorded with the external source.

When attempting to calibrate or check the calibration of the AI-1000 R2 transmitter with an external thermocouple or RTD calibrator, it is generally advisable to disable the "SENSOR FAIL-SAFE" feature. The open sensor test periodically injects about 5μA of current into the input terminals, the millivolts generated by the calibration source is periodically disturbed and depending on the characteristics of the external calibration source used, erroneous voltages may be applied to the transmitter. The "SENSOR FAIL-SAFE" can be disabled by turning it off in the configuration menus (Sections 4.7 & 5.7). After the calibration has been completed, this function can be re-enabled.

6.21 Thermocouple Input

Setting the ZERO and FULL SCALE with a thermocouple sensor requires some added steps because of the automatic cold-junction compensation. Thermocouple tables are normally available for a reference junction at the ice point of water. These table entries must be adjusted for the actual cold-junction temperature. In the case of the AI-1000 R2 transmitter, the cold-junction is measured with an internal calibrated thermometer.

It is generally good practice to operate the transmitter for 30 minutes or more prior to calibration to allow it to reach thermal equilibrium.

6.211 Calibration Using a Millivolt Source

The procedure starts with the selection of the thermocouple type. Then determine the temperature of the thermocouple terminals on top of the transmitter. This can be done by measuring with a thermometer the temperature of the thermocouple terminals on the transmitter. Or one can assume that the terminals are approximately at room temperature and then determine the room temperature.

Next, locate the appropriate table of temperature versus mV for the selected thermocouple.

Find the table entry corresponding to the terminal block temperature, (mV @ TB°C)

Calculate the mV to be applied as follows:

(mV applied for LRV) = (mV @ LRV Table°C) -(mV @ TB°C)

Applying the millivolts (mV applied) to the transmitter and record the temperature displayed on the DK-1 or DK-2 display for the ZERO (LRV) or 4mA value. Then record the FULL SCALE (URV) using a similar procedure. These recorded values will then be set into the transmitter as the zero and full-scale values using the display set-up procedure.

6.212 Calibration Using a Thermocouple Calibrator

Some of the thermocouple calibrators available on the market provide a means of measuring the temperature of the terminal block and automatically apply the corrected mV to the transmitter. This procedure is rather simple. However, there can be an appreciable difference between the temperature of the simulator and the transmitter terminals. With some thermocouple types, this error could be amplified 5 to 10 fold, resulting in large measurement errors. Use caution so as not to introduce these possible errors.

6.3 FOR BEST MEASUREMENT ACCURACY

The AI-1000 R2 transmitter is a stable instrument, precision calibrated at the factory for any measurement range the user may select. However, the automatic cold-junction compensation requires certain precautions to obtain best accuracy when used with a thermocouple sensor. Please see Accutech technical applications Tech Note #207A for additional information.

The cold-junction compensation operates by attempting to measure accurately the temperature of the thermocouple terminals on top of the instrument. If these terminals are exposed to thermal radiation or convection, the cold-junction compensation will introduce an error. With certain types of thermocouples and temperature measurement ranges, the sensitivity of the cold-junction is greater than the sensitivity of the measurement couple. Under those conditions, a one degree error in the cold-junction temperature that the transmitter senses can result in a greater than one degree temperature measurement error. See Accutech Tech Note #203A.

For best measurement accuracy with thermocouple sensors, it is advisable to shield the top terminals by placing the transmitter into a housing or enclosure, such as the model XP-FN, XP-FG, XP-HEAD, or WP-HEAD. In addition, sufficient time should be allowed for the housing and the transmitter to reach equilibrium temperature in a given operating environment before best accuracy is reached.

For best accuracy with any sensor, or in the millivolt mode, it is advisable to allow the transmitter to operate with the desired fixed input signal for a period of 30 seconds before the reading is taken. The transmitter periodically measures certain internal references. These internal measurements and the external signal undergo digital averaging and the full accuracy of the instrument is only achieved after several readings have been averaged.

When using an RTD sensor, a four-wire connection is generally recommended. With a three-wire RTD the AI-1000 R2 makes two separate measurements before calculating the temperature, whereas, only a single measurement is required when using a four-wire RTD. Conceptually, a better accuracy is possible using a single measurement as compared with calculating the difference of two separate measurements. See Accutech Tech Note # 209 for further information on the measurement accuracy improvement that is possible with true four-wire RTD measurements.

7.0 ACCESSORIES & INFORMATION

Other accessories available from Accutech are:

DK-1	One-line Local Display
DK-2	Two-line Local Display
XP-HEAD	Explosion Proof Housing (No Display Option*)
WP-HEAD	Weather Proof Housing (No Display Option*)
XP-FN	Explosion / Weather proof Housing with mounting lugs
XP-FG	Explosion / Weather proof Housing with mounting lugs and Glass Window
PY-2	Pipe Yoke to mount XP-FG or XP-FN on 2" pipe
PS-2412	Power Supply, 24/28 VDC, 1.2/0.8A
PS-2405	Power supply, 24 VDC, 0.5A

A variety of signal conditioners, thermocouples, RTD sensors and thermowells are also available.

The following Technical Application Notes are also available on special request.

Tech Note #203A Smart Temperature Transmitter Accuracy Considerations
Tech Note #207A Using the AI-1000 R2 / AI-1500 with Thermocouples
Tech Note #208A Achieving State-of-the-Art Temperature Measurement Accuracy without Individual, On-site Calibration
Tech Note #209A Unique Measuring Capabilities of the AI-1000 R2 / AI-1500

* The DK-1 or DK-2 can be used for setup and configuration for transmitters installed in XP-HEAD or WP-HEAD housings, but cannot be installed permanently. The XP-HEAD and WP-HEAD will not close properly with either of these displays installed.

8.0 SPECIFICATIONS

SENSOR INPUT	RANGE	ACCURACY	RANGE	ACCURACY
Thermocouple Type B	+ 212 to + 3,272 °F	± 1.08 ºF	+100 to 1,800 °C	± 0.6ºC
Thermocouple Type C	+ 32 to + 4,208 °F	± 0.9 ºF	+ 0 to 2,320 °C	± 0.5ºC
Thermocouple Type E	- 58 to + 1,832 °F	± 0.36 ºF	- 50 to 1,000 °C	± 0.2ºC
Thermocouple Type J	- 292 to + 1,382 °F	± 0.36 ºF	- 180 to + 750 °C	± 0.2ºC
Thermocouple Type K	- 292 to + 2,282 °F	± 0.36 ºF	-180 to 1,250 °C	± 0.2ºC
Thermocouple Type L	- 328 to + 1,652 °F	± 0.72 ºF	-200 to + 900 °C	± 0.4ºC
Thermocouple Type N	+ 32 to + 2,192 °F	± 0.36 ºF	0 to 1,200 °C	± 0.2ºC
Thermocouple Type R	+ 32 to + 2,912 °F	± 0.9 ºF	0 to 1,600 °C	± 0.5ºC
Thermocouple Type S	+ 32 to + 2,822 °F	± 0.9 ºF	0 to 1,550 °C	± 0.5ºC
Thermocouple Type T	- 238 to + 752 °F	± 0.54 ºF	-150 to + 400 °C	± 0.3ºC
Thermocouple Type U	- 148 to + 1,112 °F	± 0.72 ºF	-100 to + 600 °C	± 0.4ºC
100Ω Platinum RTD DIN Curve (α = 0.00385)	- 328 to + 1,562 °F	± 0.14 ºF	-200 to + 850 °C	± 0.08ºC
100Ω Platinum RTD SAMA Curve (α = 0.003923)	- 328 to + 1,193 °F	± 0.14 ºF	-200 to + 645 °C	± 0.08ºC
Call Factory for 100Ω Ni, 120Ω Ni, and 10Ω Cu				
Millivolt	- 15 to 115mV	± 0.006 mV		
Ohm	0 to 500 Ω	± 0.002 Ω		

LINEARIZATION: Thermocouple and RTD linearization to ±0.05ºC. Custom linearization with 22 point curve (consult factory).

OUTPUT: Analog, Two-wire 4 to 20mA

TRANSMITTER ACCURACY: ± 0.05% of the millivolt or ohm equivalent input reading, or the value from the Accuracy Table, whichever is greater; plus ±0.05% of the span. For thermocouples, add ±0.5°C (0.9°F) for cold junction effect.

Accuracy includes transmitter repeatability, hysteresis and linearity as well as ambient temperature effect, A/D conversion error, analog output error, line voltage effects, humidity effect under non-condensing conditions and vibration effect to 2g's & 500Hz.

TRANSMITTER REPEATABILITY: One-half the transmitter accuracy.

COLD-JUNCTION COMPENSATION: Digital self-correcting over the ambient temperature range to within ±0.5°C.

OUTPUT RANGING ADJUSTMENTS:

Analog Zero: 100% of Sensor range – Noninteracting
Analog Full-scale: Normal or Reverse Acting

AMBIENT TEMPERATURE STABILITY: Self-Correcting over the operating temperature range.

LONG TERM STABILITY: Stability deviation per year is less than: (0.025% of output the span + 0.05% of the reading)

OPERATING TEMPERATURE RANGE:

-40°C to +85°C	-40°F to + 185°F	Electronics
-20°C to +70°C	- 4°F to + 158°F	Display (Full Visibility)
-40°C to +85°C	-40°F to + 185°F	Display (With reduced visibility)

STORAGE TEMPERATURE RANGE: -50°C to +85°C, -58°F to +185°F

DAMPING: Factory selectable time constant (63%) from 0 to 32 sec.

FAILSAFE: User settable to 3.6mA or 23mA.

MOUNTING POSITION: No effect on measurement value.

WEIGHT: AI-1000 R2: 6 oz. XP-FN & FG: 2½ lbs. WP-HEAD: 12 oz

ISOLATION: Input to Output 500VAC

INPUT IMPEDANCE: Greater than 1 MΩ

POWER SUPPLY: The transmitter operates on 12 to 42 VDC (30VDC for I/S installations) with no load. Transmitter is protected against reverse polarity connection.

LOAD LIMITATIONS: Loop resistance including optional indicator: R(KΩ) = (Supply Voltage - 12 VDC) / (23mA)

ELECTROMAGNETIC COMPATIBILITY (CE COMPLIANCE): Transmitter operates within specification in fields from 20 to 1,000MHz with field strengths to 30V/m. Meets EN 50082-1 Generic Immunity Standard and EN 55011 Compatibility Emissions Standard.

DYNAMIC RESPONSE:

UPDATE RATE: 150 milliseconds (7 times per second), typical.
RESPONSE TO STEP CHANGE: 250 milliseconds, minimum; 1 second, typical.
START-UP TIME: 7 sec. Operation to specification in less than 30 sec.
AMBIENT TEMPERATURE CHANGE: Self-correcting for ambient temperature changes up to 20°C/hr.

INTERCHANGEABILITY: Fully interchangeable without field calibration

HAZARDOUS LOCATION CERTIFICATIONS:

Explosion Proof: Explosion Proof Housings available with and without windows; CSA and FM approved for Class I, Div I & II, Groups B, C, & D; Class II, Div I & II, Groups E, F & G, Class III and are rated for NEMA 4X and NEMA 7 environments.

Nonincendive: Transmitter is CSA and FM rated nonincendive in Class I, Div II, Groups A, B, C & D; Class II, Div II, Groups F & G, Class III, Div II, CENELEC Ex N IIC T4-T6 certification pending.

Intrinsic Safety: The Intrinsically Safe Rated Model AI-1000 R2 I/S Transmitter is CSA and FM rated Intrinsically Safe for Class I, Div I, Groups A, B, C & D and Class II, Div I, Groups E, F, & G, and Class III, Div I, installed in accordance with AIC Drawing 6022588. CENELEC EEx ia IIC T4-T6 Intrinsically Safe certification pending.

OPTIONS:

INTRINSIC SAFETY: Order the AI-1000 R2 I/S
HOUSINGS:
XP-FN: NEMA 7 Explosion-Proof, NEMA 4X Housing
XP-FG: NEMA 7 Explosion-Proof, NEMA 4X with Window
XP-HEAD: NEMA 7 Explosion-Proof, Rain-tight Head
WP-HEAD: IP66 Weatherproof Head
DISPLAYS:
DK-1: One-Line Local Display and Keyboard
DK-2: Two-Line Smart Local Display and Keyboard
THERMOWELLS: Order as required. See Accutech Bulletin PROB
SENSORS: Order as required. See Accutech Bulletin PROB
EXPLOSION-PROOF CERTIFICATION: Consult factory for details
MOUNTING:
PY-2: 2" Pipe Yoke for XP-FN & XP-FG housings
DIN-KIT R2: DIN Rail Mounting Adapter

STANDARD CONFIGURATION:

Sensor Input	J Type Thermocouple
LRV (4mA)	40ºF Lower Range Value
URV (20mA)	200°F Upper Range Value
Damping	0 seconds
Output	Linear with Temperature
Failsafe	Upscale (23mA)

ORDERING INFORMATION: Please order Model AI-1000 R2. Specify custom configuration, options and companion products as desired.

NOTE: Please note that specifications are determined with the factory default software settings or with the various software parameters set to optimize the performance for a given specification.

LIMITED WARRANTY

This warranty is in lieu of all other warranties, expressed or implied. The Accutech 1000 series products (Product) are warranted by Adaptive Instruments, LLC (The Seller) to be free from defects in workmanship and materials, under conditions of normal use and service, for a period of two years from the date of shipment. At its option, the Seller will repair, replace, or recalibrate, free of charge, any Product or Products found and determined to be defective by the Seller if returned to the Seller, per the procedure below, within two years of its original purchase.

To claim a repair or replacement under this warranty, a Return Material Authorization (RMA) number must be obtained from Adaptive Instruments LLC or its operating division, Accutech, and the Product returned, postpaid to the Seller. Final warranty defect determination and determination of the cost, if any, to repair or replace will be made by the Seller upon examination of the returned Product. Returned units may be subject to an evaluation or recalibration charge as listed in the Seller's price list.

Defects arising from negligence, misuse, improper installation, accident, modification or alteration of this Product (or Products) are not warranted nor are Products that have been opened for on-site or field inspection or repair.

LIABILITY OF THE SELLER

Liability of the Seller is limited to repair or replacement of the Product or Products as outlined above. Purchaser assumes full responsibility for determining that the Product or Products purchased will meet the Purchaser's requirements or those of the Purchaser's customers. Purchaser agrees to indemnify, defend and hold the Seller harmless from any liability, loss, or damage, whatsoever, caused or alleged to be caused directly or indirectly by the Product or Products including, but not limited to any interruption of business, loss of business, personal injury or consequential damages resulting from the use or operation of the Product or Products.

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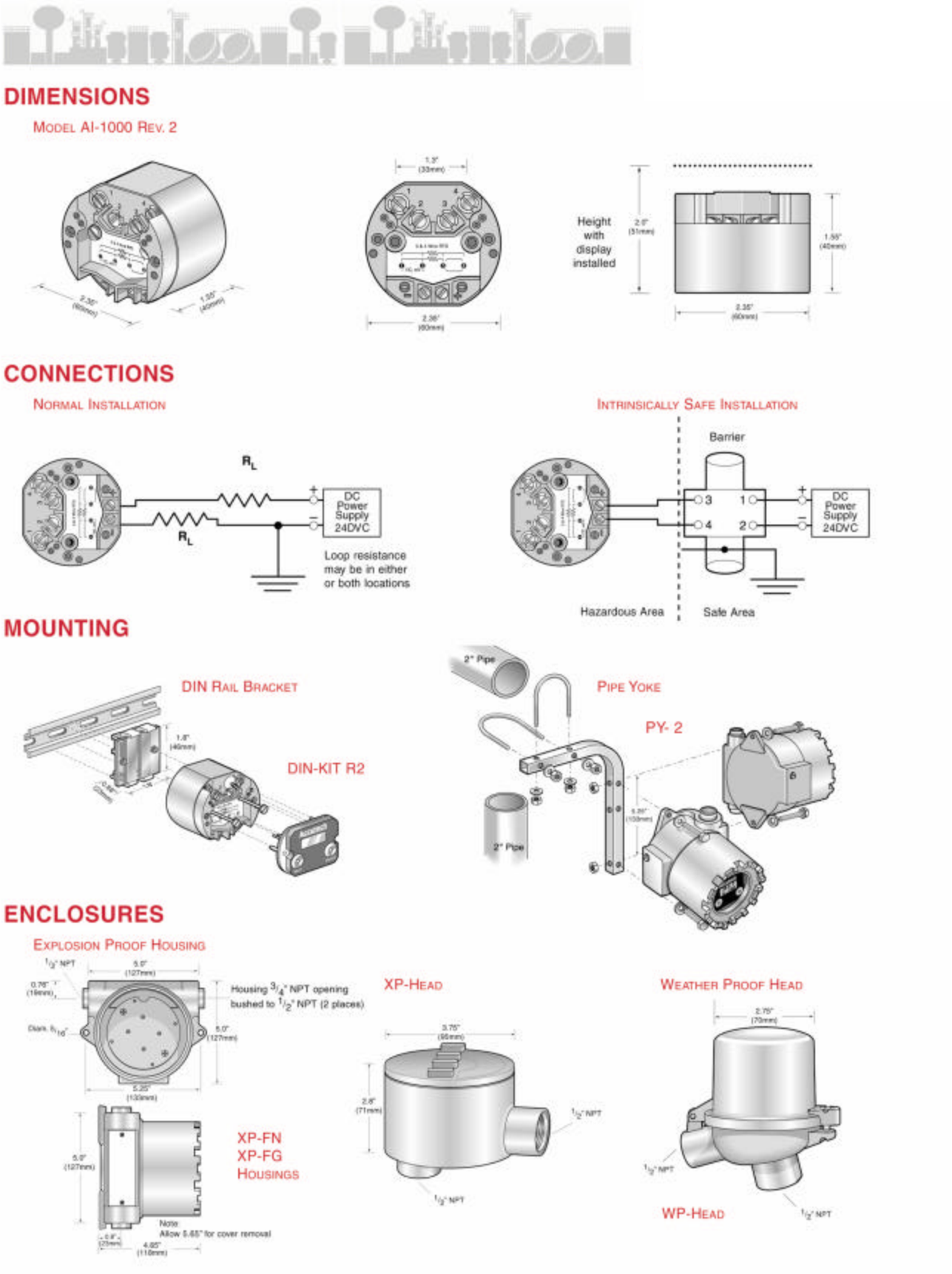
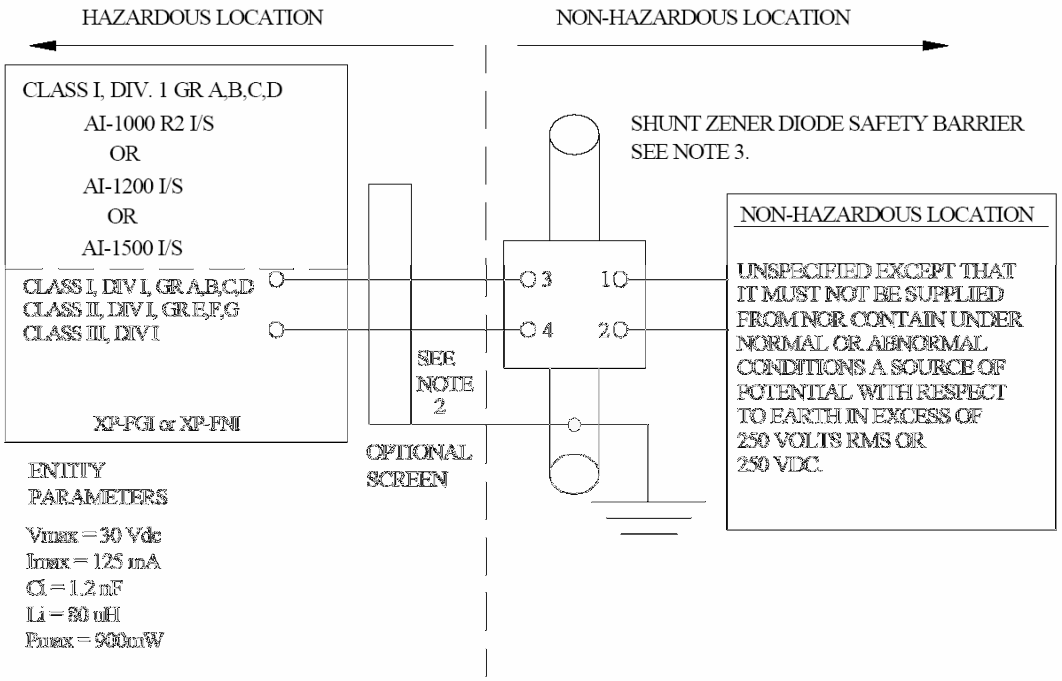


Figure 8-1
Mechanical Dimensions

REV	DATE	BY	CHK'D	DESCRIPTION
A	6/1/99	RRS	JK	Release ECO461
B	01/06/00	SR	JK	ECO 511 Private Labeler

AI-1000 R2 I/S, AI-1200 I/S, AI1500 I/S, XP-FNI, XP-FGI

Factory Mutual & Canadian Standards Association
Approved Intrinsically Safe Installation Control Drawing


HAZARDOUS LOCATION
NON-HAZARDOUS LOCATION
CLASS I, DIV. 1 GR A,B,C,D
AI-1000 R2 I/S
OR
AI-1200 I/S
OR
AI-1500 I/S
CLASS I, DIV I, GR A,B,C,D
CLASS II, DIV I, GR E,F,G
CLASS III, DIV I
XP-FGI or XP-FNI
SEE NOTE 2
OPTIONAL SCREEN
SHUNT ZENER DIODE SAFETY BARRIER
SEE NOTE 3.
3
1
4
2
NON-HAZARDOUS LOCATION
UNSPECIFIED EXCEPT THAT IT MUST NOT BE SUPPLIED FROM NOR CONTAIN UNDER NORMAL OR ABNORMAL CONDITIONS A SOURCE OF POTENTIAL WITH RESPECT TO EARTH IN EXCESS OF 250 VOLTS RMS OR 250 VDC.
ENTITY PARAMETERS
Vmax = 30 Vdc
Imax = 125 mA
Ci = 1.2 nF
Li = 80 uH
Pmax = 900mW

NOTES:

1. The electrical circuit in the hazardous area must be capable of withstanding an A.C. test voltage of 500 volts R.M.S. to earth or frame of the apparatus for one minute.

2. Cable capacitance and inductance plus the I.S. apparatus unprotected capacitance (Ci) and inductance (Li) must not exceed the allowed capacitance (Ca) and inductance (La) indicated on the associated apparatus.

3. Any positive polarity shunt zener diode safety barrier approved by FMRC or CSA for groups A, B, C, D, E, F, and G whose output parameters are:

Voc or Vt	≤	30 Vdc
Isc or It	≤	125 mA
Ca	≥	Ci + C cable
La	≥	Li + L cable

4. The installation including the barrier earthing arrangements must comply with the installation requirements of the country of use, i.e. ANSI/ISA RP12.6 (installation of intrinsically safe systems for hazardous (classified) locations) and The National Electrical Code, ANSI/NFPA 70 or Canadian Electrical Code part 1. Installation must be in accordance with the manufacture's guidelines.

5. Temperature Code: T4 at maximum ambient temperature of 85° C
   T6 at maximum ambient temperature of 40° C

6. Dust-tight conduit seal must be used when installed in class ii and iii environments.

NO REVISIONS ALLOWED WITHOUT PRIOR FACTORY MUTUAL OR CANADIAN STANDARDS ASSOCIATION APPROVAL.

NOTICE:
This drawing and specifications, herein, are the proprietary property of ADAPTIVE INSTRUMENTS CORP. and shall not be reproduced in whole or in part as the basis for manufacture or sale without prior written permission from Adaptive Instruments Corp.

Drawn By:	Date:						
RRS	5/20/99						
Chkd By:	Date:	TITLE: Accutech FM/CSA I/S Control Drawing					
JK	5/20/99						
Released By:	Date:	Scale	Size	Drawing NO	Rev	Sheet	
RRS	5/20/99		A	6022 588	B	1 of 1	

Figure 8-2
Intrinsic Safety Approval Drawings

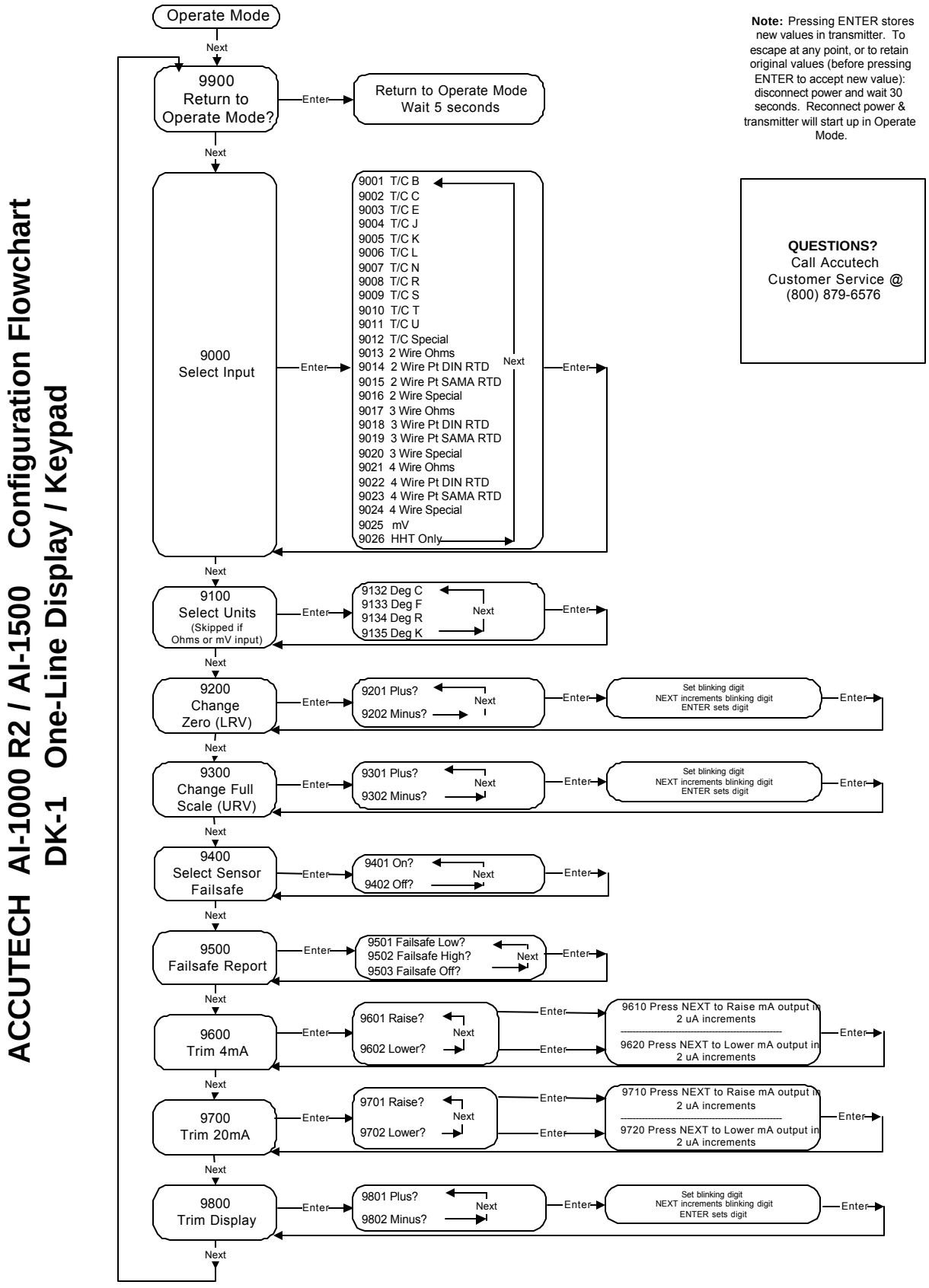


Figure 8-3
DK-1 One Line Display Configuration Flowchart

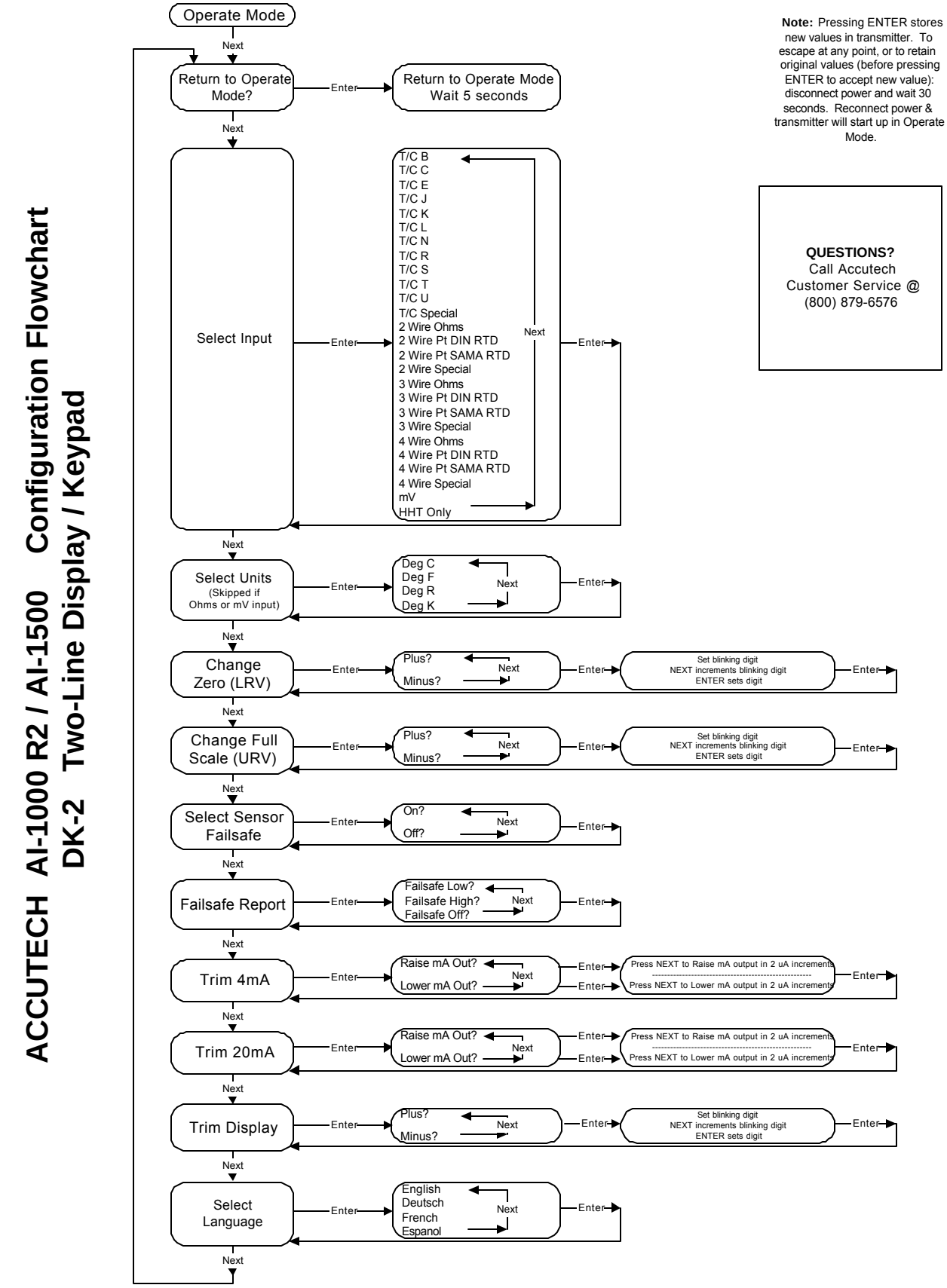


Figure 8-4
DK-2 Two Line Display Configuration Flowchart

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